REMARKS

In response to the Office Action dated March 11, 2006, Applicant has amended claims 1,2,4,13, 14, 17 and 19 and cancelled claim 3. No new matter is added. The amendments to the claims are for purposes of clarity and are not in response to the rejections by the Examiner.

The primary objection by the Examiner to the application is the rejection pursuant to 35 U.S.C. §101 because the Examiner believes that the invention is not supported by either a credible asserted or well-established utility. The Examiner's rejection of the claims under 35 U.S.C. §112 is based on the same belief by the Examiner that the invention does not meet the utility and/or enablement standard. Applicant respectfully traverses this rejection.

It is well established that there is a correlation between galactic cosmic rays and cloud cover. It appears that the cosmic rays ionize molecules in the atmosphere that can then become ion clusters which will either charge existing aerosols or else form their own charged aerosols that can grow aggressively to the point of becoming the bases of rain drops. While the majority of the ions produced by the cosmic rays recombine and are neutralized, some of those that attach to an aerosol will energize that aerosol, increasing its probability of growing to water droplets. When the water droplets reach sufficient size, rain will form. This is described in the references cited in a paper by the inventor, Phillip Kauffman, and Arquimedes Ruiz-Columbie, entitled "Artificial Atmospheric Ionization: A Potential Window for weather modification" (the "Paper"), delivered at the 16th Conference of the American Meteorological Society on Planned and Inadvertent Weather Modification, January 9-13, 2005. A copy of the agenda and the Paper are attached as Exhibit A.

As is set forth in the Paper, since cosmic rays cause ionization in the atmosphere that has been correlated to many different atmospheric processes that ultimately lead to the formation of water droplets and associated weather changes, other methods of causing ionization in the atmosphere should also act as nuclei for the nucleation, coalescence, condensation and collision of atmospheric particles, allowing them to grow to the size of water droplets and rain drops. This is the underlying theory for the invention; once local ionization of particles is achieved, the source of ionization is irrelevant. The present inventor did not

develop the idea that charged particles can enhance the formation of water droplets; rather, he is using that well established scientific fact and applying it.

The references cited by the Examiner do not establish that utility is missing. The Moore article suggests that there is a disagreement among scientists. The Mexican government has been building ionization installations for weather modification. The criticism cited by the Examiner from the Moore article can be distinguished. The only criticism that provides a scientific basis rather than opinion is that of Dr. Tinsley, who relies on the 250,000 volt difference between the ionosphere and the ground. However, the ions generated in the present invention are not directed at the ionosphere, which is about 100 miles above earth but rather at the layer about one half mile above ground level. It is the localized concentration of ions, not the total votage difference that is important. While it is clear that the claimed antenna will not generate the 250,000 volt difference between the ground and the ionosphere, it will generate several orders of magnitude more voltage difference between ground and the layer of interest for weather modification (about ½ mile above ground level, where much of the precipitation activity is concentrated).

The Examiner also relies on the April 22, 2004, Summary of Minutes from the Texas Weather Modification Advisory Committee. At this meeting, The Committee did not rule on the application but requested more information. However, what was not appended to the Office Action was the Minutes from the same Committee dated Ausust 12, 2004, the follow-up meeting. A copy of those Minutes is attached as Exhibit B. At this meeting, the inventor, Mr. Kauffman, spoke to the Committee and the application for a Texas Weather Modification License was granted to Ionogenics. Thus, in light of the information provided by the inventor, the Committee reversed its earlier position relied on by the Examiner and authorized the operation and implementation of a weather modification ionization station in Texas which has been and is currently producing a wide array of atmospheric research data.

The other references relied on by the Examiner are merely news articles, written by reporters totally unfamiliar with the fields of weather modification and atmospheric physics or chemistry, which simply are reporting opinions. They are not sufficient to raise a § 101

objection. Therefore, Applicant believes that utility, and enablement, are clearly established.

The sole rejection on the basis of prior art concerned the Carpenter, Jr. U.S. Patent No. 4,180,698. Applicant believes that claim 1, as amended, clearly traverses this rejection. Carpenter merely shows a device for providing protection against atmospheric effects such as corona discharge and lightening strikes. There is no power source to cause it to act as an ionization antenna. As such, it is different in kind than the claimed invention.

In light of the foregoing, Applicant considers that the claims, as amended, are in condition for allowance. Prompt notification of allowance is requested.

Respectfully submitted,

Date: June 12, 2006

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16th Conference on Planned and Inadvertent Weather Modification (Expanded View)

Sunday, 9 January 2005

7:30 AM-9:00 AM, Sunday
Short Course Registration

9:00 AM, Sunday
Conference Registration

Monday, 10 January 2005

6:00 AM, Monday
MON 10 JAN

7:30 AM, Monday
Registration continues through Thursday, 13 January

9:00 AM-10:00 AM, Monday
Session 1 all aspects of planned and inadvertent weather modification
Chairpersons: Joseph H. Golden, Forecast Systems Lab, NOAA, Boulder, CO; Patrick Sweeney, Weather Modification, Inc., Fargo, ND

9:00 AM	1.1	A plan for the next phase in weather modification science and technology development PDF **T. P. DeFelice**, AIS, Sykesville, MD
	1.2	PAPER WITHDRAWN
9:15 AM	1.3	A PDA-based record keeping system for cloud seeding operations PDF **Paul T. Moen**, North Dakota State Water Commission, Bismarck, ND; and D. W. Langerud
9:30 AM	1.4	Satellite Retrieved Microphysical Properties of AgI Seeding Tracks in Supercooled Layer Clouds **Daniel Rosenfeld**, The Hebrew University of Jerusalem, Jerusalem, Israel; and X. Yu and J. Dai
9:45 AM	1.5	Hail Metrics Using Conventional Radar PDF G. Brant Foote, NCAR, Boulder, CO; and **T. W. Krauss** and V. Makitov

10:15 AM, Monday
Coffee Break in Poster Session Room

10:45 AM-11:45 AM, Monday
Session 2 inadvertent weather modification on urban effects on fog, clouds, precipitation, runoff, and lightning
Chairpersons: Robert D. Bornstein, San Jose State University, San Jose, CA; Don A. Griffith, North American Weather Consultants, Sandy, UT

10:45 AM 2.1 Urban and Industrial Aerosols Impacts on Precipitation
Daniel Rosenfeld, The Hebrew University of Jerusalem, Jerusalem, Israel

11:00 AM 2.2 Separation between cloud seeding and air pollution effects
Amir Givati, Hebrew University, Jerusalem, Israel; and D. Rosenfeld

11:15 AM 2.3 Modeling the impacts of urban aerosol on convection and precipitation
Susan C. Van den Heever, Colorado State University, Fort Collins, CO; and W. R. Cotton

11:30 AM 2.4 Analysis of Upper Air, Ground and Remote Sensing Data for the ATLAS Field Campaign in San Juan, Puerto Rico
Jorge E. Gonzalez, Santa Clara University, Santa Clara, CA; and J. Luvall, D. Rickman, D. E. Comarazamy, and A. J. Picon

11:45 AM 2.5 MM5 simulations of uhi-induced thunderstorms over Atlanta, GA
Bob Bornstein, San Jose State Univ., San Jose, CA; and K. J. Craig and Q. Lin

12:00 PM, Monday
Lunch Break

2:30 PM, Monday
Formal Poster Viewing with Coffee Break

2:30 PM-4:00 PM, Monday
Poster Session 1 Poster Session

P1.1 Modeling the complex interactions among urban climate, air quality, and adaptive/reactive human response
David J. Sailor, Portland State University, Portland, OR; and R. D. Bornstein, L. George, J. Semenza, and H. Taha

P1.2 Probe into the Hail Formation Mechanism on the Northeastern Border of Qinghai-Xizang Plateau and its Neighbourhood
Kang Fengqin, Lanzhou Institute of Arid Meteorology, Lanzhou, Gansu, China; and Z. Qiang and G. Xueliang

P1.3 Fog Aerosol analysis and cloud seeding experiments at DaeGwalryoung, Korea.
Sung-Nam Oh, Meteorological Research Institute / Korea Meteorological Administration, Seoul, South Korea; and Y.-H. Kim, J.-Y. Kim, G.-M. Park, J.-Y. Jeong, and H.-Y. Yang

P1.4 Impacts of Cloud Seeding on COOP Precipitation Measurements in the Southern Plains
Bradley G. Illston, Oklahoma Climatological Survey/Univ. of Oklahoma, Norman, OK

P1.5 PAPER WITHDRAWN

P1.6 Effect of air pollution on precipitation along the Front Range of the Rocky Mountains
Israel L. Jirak, Colorado State University, Fort Collins, CO; and W. R. Cotton and W. L. Woodley

P1.7 Application of a hydrologic model to assess the effects of cloud seeding in the Walker river basin of Nevada
Douglas P. Boyle, DRI, Reno, NV; and G. Lamorey and A. Huggins

P1.8 A Model Based Feasibility Study of Glacionic Seeding during a Winter Orographic Precipitation Event in Wyoming

Tara Jensen, NCAR, Boulder, CO; and R. Bruintjes, D. Breed, W. D. Hall, B. Boe, and K. Ross

P1.9 PAPER WITHDRAWN

P1.10 Three-dimensional modeling of North Dakota clouds using a new microphysical scheme with explicit treatment of atmospheric aerosols and hygroscopic seeding effects
Richard D. Farley, South Dakota School of Mines and Technology, Rapid City, SD; and M. R. Hjelmfelt and S. L. Hansen

P1.11 THE UNFORTUNATE ACADEMY REPORT ON WEATHER MODIFICATION
Roland List, University of Toronto, Toronto, Ontario, Canada

P1.12 Summary of trace chemical and physical measurements of snowfall in two Nevada cloud seeding target areas
Arlen W. Huggins, DRI, Reno, NV; and P. R. Edwards and J. R. McConnell

P1.13 The Magnifying Glass Versus The Rubber Stamp—The Role of Statistics in Weather Modification
Tressa L. Fowler, NCAR, Boulder, CO; and B. G. Brown and E. Gilleland

4:00 PM-5:30 PM, Monday
Session 3 development and refinement of conceptual models; application of numerical models to planned and inadvertent weather modification topics
Chairperson: Tara Jensen, NCAR, Boulder, CO

4:00 PM 3.1 Purposeful tornado amelioration: Is the science ready?
Joseph H. Golden, Forecast Systems Lab, NOAA, Boulder, CO

4:15 PM 3.2 Modeled sensitivity of wintertime precipitation to CCN and GCCN concentrations
Stephen M. Saleeby, Colorado State University, Fort Collins, CO; and W. R. Cotton

4:30 PM 3.3 Impacts of urban and rural land-use and land-cover changes on MM5 simulated meteorological conditions in the Houston-Galveston region
Haider Taha, Altostratus, Inc., Martinez, CA; and R. D. Bornstein and R. Balmori

4:45 PM 3.4 Dynamic climatology—a tool for assessing cloud seeding operations in water resource management
William J. Badini, HDR Engineering Inc., Denver, CO; and J. F. Henz

5:00 PM 3.5 A case study of mesoscale and plume dispersion modeling for a February 2004 cloud seeding event in the Walker River Basin of California/Nevada
Arlen W. Huggins, DRI, Reno, NV; and D. Koracin, D. Podnar, and M. Xiao

5:15 PM 3.6 Controlling the evolution of a simulated hurricane through optimal perturbations: Initial experiments using a 4-D variational analysis system
R. N. Hoffman, AER, Lexington, MA; and C. Grassotti, J. M. Henderson, S. M. Leidner, G. Modica, and T. Nehrkorn

5:30 PM-7:00 PM, Monday
FORMAL OPENING OF EXHIBITS WITH RECEPTION (CASH BAR)

5:30 PM, Monday
Conference Ends

7:30 PM, Monday
Suki Manabe Symposium Banquet

Tuesday, 11 January 2005

8:30 AM-10:00 AM, Tuesday
Session 4 Planned weather modification including promising new technologies such as the recent hygroscopic and winter orographic seeding experiments and evaluation methods for seeding experiments

Chairpersons: William L. Woodley, Woodley Weather Consultants, Littleton, CO; Darin W. Langerud, North Dakota Atmospheric Resource Board, Bismarck, ND

8:30 AM 4.1 The Santa Barbara Cloud Seeding Project in Coastal Southern California, Operations and Research Spanning More Than 50 Years
Don A. Griffith, North America Weather Consultants, Sandy, UT; and M. E. Solak, R. B. Almy, and D. Gibbs

8:45 AM 4.2 Observations of rime icing in the Wasatch Mountains of Utah: implications regarding winter season cloud seeding
Mark E. Solak, North American Weather Consultants, Sandy, UT; and D. P. Yorty and D. A. Griffith

9:00 AM 4.3 The search for the optimal size of hygroscopic seeding particles
Ronen Lahav, The Hebrew University, Jerusalem, Israel; and D. Rosenfeld

9:15 AM 4.4 Precipitation Evaluation of the North Dakota Cloud Modification Project (NDCMP) using the ND ARBCON Precipitation Data
Paul A. Kucera, University of North Dakota, Grand Forks, ND; and E. Wise

9:30 AM 4.5 The Snowy Precipitation Enhancement Research Program
Mark F. Heggli, Innovative Hydrology, Auburn, CA; and B. Dunn, A. W. Huggins, J. Denholm, L. Angri, and T. Luker

9:45 AM 4.6 Artificial Atmospheric Ionization: A Potential Window for Weather Modification
Phillip Kauffman, Ionogenics Corp., Bedford, MA; and A. Ruiz-Columbié

11:00 AM-12:00 PM, Tuesday
Session 5 recent developments in understanding natural cloud processes and aerosol cloud interactions and how they might be modified - Part 1

Chairperson: Roelof T. Bruintjes, NCAR, Boulder, CO

11:00 AM 5.1 The impacts of Saharan dust on Florida storm characteristics
Susan C. van den Heever, Colorado State University, Fort Collins, CO; and G. G. Carrió, W. R. Cotton, and W. C. Straka

11:15 AM 5.2 Modifying particle size distributions in hygroscopic cloud Seeding flares and the effects on the warm rain process in convective clouds
Vidal Salazar, NCAR, Boulder, CO; and R. T. Bruintjes and J. Gunkelman

11:30 AM 5.3 On the stochastic nature of droplet growth by coalescence
A. B. Kostinski, Michigan Technological University, Houghton, MI

11:45 AM 5.4 The Relationship between Cloud Droplet Distributions and Ambient Aerosol Populations in a Subtropical Desert Region
Tara Jensen, NCAR, Boulder, CO; and V. Salazar, D. Breed, R. Bruintjes, S. Piketh, A. Al Mangoosh, and A. Al Mandoos

11:30 AM-1:30 PM, Tuesday
Exhibits Open

12:00 PM, Tuesday
Lunch Break

1:30 PM-3:00 PM, Tuesday
Session 6 RECENT DEVELOPMENTS IN UNDERSTANDING NATURAL CLOUD PROCESSES AND AEROSOL CLOUD INTERACTIONS AND HOW THEY MIGHT BE MODIFIED - Part 2

Chairpersons: Daniel Rosenfeld, The Hebrew University of Jerusalem, Jerusalem 91904, Israel; Daniel Breed, NCAR, Boulder, CO

1:30 PM	6.1	Aerosol Intercations on Clouds with emphasis on the Arabian peninsula **Roelof T. Bruintjes**, NCAR, Boulder, CO; and V. Salazar, D. Breed, J. Li, P. R. Buseck, T. Jensen, S. Piketh, and J. Reid
1:45 PM	6.2	On the Documentation of Microphysical Signatures Following the Base-Seeding of Texas Convective Clouds Using Salt Micro-Powder **William L. Woodley**, Woodley Weather Consultants, Littleton, CO; and D. Rosenfeld, D. Axisa, R. Lahav, and G. Bomar
2:00 PM	6.3	Studies of Background Cloud Condensation Nucleus Population Characteristics in the Northern High Plains **A. Detwiler**, South Dakota School of Mines & Technology, Rapid City, South Dakota
2:15 PM	6.4	The mechanism of increase of precipitation efficiency by large aerosols and the optimum size of seed particles **Khain Alexander**, The Hebrew University of Jerusalem, Jerusalem 91904, Israel; and D. Rosenfeld, A. Pokrovsky, and Y. Segal
2:30 PM	6.5	Saharan dust and optical properties of anvil-cirrus clouds **Gustavo Carrió**, Colorado State University, Fort Collins, CO; and S. C. Van den Heever and W. R. Cotton
2:45 PM	6.6	The Southern Plains Experiment in Cloud Seeding of Thunderstorms for Rainfall Augmentation (SPECTRA) project: Operational tools used towards verifying glaciogenic and hygroscopic seeding conceptual models, case studies and preliminary results. **Duncan Axisa**, SOAR program, Plains, TX; and D. Rosenfeld, J. L. Santarpia, W. L. Woodley, and D. R. Collins

3:00 PM, Tuesday
Coffee Break in Exhibit Hall

3:00 PM-5:00 PM, Tuesday
Exhibits Open

3:30 PM-5:30 PM, Tuesday
Joint Session 6 the water cycle in arid lands (Joint with 16th Conference on Planned and Inadvertent Weather Modification and AMS Forum on Living with a Limited Water Supply)

Chairperson: John L. Wilson, New Mexico Institute of Mining and Technology, Socorro, NM

3:30 PM J6.1 Topographic and Ecosystem Controls on Soil Moisture Distribution in the SMEX04-NAME Transect Study, Northern Sonora, Mexico
Enrique R. Vivoni, New Mexico Institute of Mining and Technology, Socorro, NM; and H. A. Gutierrez, B. Brooks, C. A. Aragon, A. Rinehart, R. Wyckoff, C. J. Watts, J. C. Rodriguez, and T. J. Jackson

3:45 PM J6.2 Seasonal strategies to enhance groundwater recharge in hyper-arid zones
David N. Yates, NCAR, Boulder, CO; and A. Mangoosh, M. AlMalki, and R. T. Bruintjes

4:00 PM J6.3 Refinement of Numerical Modeling and technology of Global and Regional Water Cycle
Hiromasa Ueda, Disaster Prevention Research Institute, Kyoto University, Uji City, Kyoto, Japan; and T. Yamagata, R. Ohba, H. Sakuma, S. Behera, M. Mujumdar, and A. Chakraborty

4:15 PM J6.4 MM5 Simulations of Precipitation in the El Paso Del Norte
Karina Apodaca, Howard University, Washington, DC; and D. V. R. Morris

4:30 PM J6.5 Mitigating climate risks through hydro-climate information and adaptive water management institutions
Andrea J Ray, NOAA/CDC, Boulder, CO

4:45 PM J6.6 Influence of soil and vegetation on rainfall in coastal desert and mountainous area
Ryohji Ohba, Mitsubishi Heavy Industries, Fukahorimachi, Nagasaki, Japan; and H. Ueda, T. Adachi, T. Hara, R. W. A. Hutjes, H. W. Ter Maat, and B. Bisselink

5:00 PM J6.7 Hydroclimatology of the North American Monsoon Region in Northwest Mexico
David J. Gochis, NCAR, Boulder, CO; and L. Brito-Castillo and W. J. Shuttleworth

5:15 PM J6.8 Geostatistical Mapping of Mountain Precipitation Incorporating Auto-searched Effects of Terrain and Climatic Characteristics
Huade Guan, New Mexico Institute of Mining and Technology, Socorro, NM; and J. L. Wilson and O. Makhnin

4:30 PM, Tuesday
Sessions End for the day

5:45 PM, Tuesday
Sessions end for the day

Wednesday, 12 January 2005

8:30 AM-9:30 AM, Wednesday
Joint Session 7 extreme water cycle events: floods and droughts (JOINT BETWEEN THE LIMITED WATER SUPPLY SYMPOSIUM, THE 19TH CONFERNCE ON HYDROLOGY, and the 16th Conference on Planned and Inadvertent Weather Modificaiton) (parallel with Session 3)

Chairperson: Kevin Trenberth, NCAR, Boulder, CO

8:30 AM J7.1 Pro-active drought mitigation in the United States: practical and theoretical Insights from a national survey of state drought planning impact and vulnerability assessments
Joseph S Abraham, Department of Geography and Regional Development, the University of Arizona, Tucson, Arizona

8:45 AM J7.2 Long-Lead Drought Forecasting – Lessons Learned in the Murray-Darling Basin, Australia
A. P. Barros, Duke University, Durham, NC; and G. Bowden

9:00 AM J7.3 Analysis of Precipitation Variability and Meteorological Drought in the Apalachicola-Chattahoochee-Flint River Basin
Gloria Arrocha, Florida State University, Tallahassee, FL; and P. Ruscher

9:15 AM J7.4 Agricultural drought: an index based on transpiration deficit
Vittorio Marletto, ARPA Emilia-Romagna, Bologna, Italy; and F. Zinoni and T. Tonelli

9:30 AM, Wednesday
Coffee Break

10:00 AM-12:00 PM, Wednesday
Presidential Forum

11:30 AM-1:30 PM, Wednesday
Exhibits Open

12:00 PM, Wednesday
Lunch Break

1:30 PM-5:00 PM, Wednesday
Session 7 The Weather Damage Modification Program
Chairperson: Andrew Detwiler, South Dakota School of Mines and Technology, Rapid City, SD

1:30 PM 7.1 The Weather Damage Modification Program PDF
Steven M. Hunter, U.S. Bureau of Reclamation, Denver, CO; and J. Medina and D. A. Matthews

1:45 PM 7.2 Preliminary Results from a Randomized Winter Propane Seeding Experiment in Utah
James A. Heimbach, Jr., UNCA, Springvale, ME; and A. B. Super

2:00 PM 7.3 An Overview of Results from the Nevada Weather Damage Modification Program
Arlen W. Huggins, DRI, Reno, NV; and D. Koracin, D. P. Boyle, and M. Xiao

2:15 PM 7.4 North Dakota Research Foci under the Weather Damage Modification Program
Darin W. Langerud, North Dakota Atmospheric Resource Board, Bismarck, ND; and C. A. Grainger, P. Kucera, E. Wise, A. Detwiler, R. D. Farley, F. J. Kopp, M. R. Hjelmfelt, P. L. Smith, and P. W. Mielke

2:30 PM Formal Poster Viewing with Coffee Break

4:00 PM 7.5 Numerical Simulations of Snowpack Augmentation for Drought Mitigation Studies in the Colorado Rocky Mountains
Curtis L. Hartzell, Project Consultant for the Colorado Water Conservation Board, Denver, CO; and J. Busto, W. R. Cotton, R. McAnelly, G. Carrió, and L. Hjermstad

4:15 PM 7.6 Overview of Research and Field Observation Activities in Texas and Oklahoma
Kenneth Howard, NOAA/NSSL, Norman, OK; and N. Kuhnert

4:30 PM 7.7 The Southern Plains Experiment in Cloud seeding of Thunderstorms for Rain Augmentation (SPECTRA) Project: The Study and Validation of Rain-Enhancement Strategies for the Mitigation of Drought in the Southern U. S. Great Plains Region
Duncan Axisa, SOAR program, Plains, TX; and G. Bomar and W. L. Woodley

4:45 7.8 Weather Modification operations with NEXRAD level-II data and products PDF

PM　J. T. Johnson, Weather Decision Technologies, Norman, OK; and C. Barrere, **M. D. Eilts**, N. Kuhnert, M. Mathis, and D. Axisa

3:30 PM-6:30 PM, Wednesday
Exhibits Open

7:30 PM, Wednesday
AMS Annual Awards Banquet

Thursday, 13 January 2005

8:30 AM-9:45 AM, Thursday
Joint Session 8 Understanding and predicting the water cycle across scales (Joint between the Limited Water Supply Symposium, the 19th Confernce on Hydrology, and the 16th Conference on Planned and Inadvertent Weather Modification) (parallel with Session 5)

Chairperson: Roy Rasmussen, NCAR, Boulder, CO

8:30 AM	J8.1	What is causing the decline in coastal rainfall in eastern Australia? **Jozef Syktus**, Queensland Centre for Climate Applications, Indooroopilly, Queensland, Australia
8:45 AM	J8.2	Using Model-Assimilated Meteorological Data in Forecasting of Seasonal Runoff Based on Statistical Models for some Aral Sea Sub-catchments PDF **Mariya G. Glazirina**, Institute for Atmospheric and Climate Science, ETH Zurich, Switzerland; and R. Schiemann, J. Gurtz, L. Vasilina, F. Pertziger, S. Dirren, and C. Schär
9:00 AM	J8.3	Trends and variability in precipitable water, and surface freshwater flux (precipitation minus evaporation). **Kevin E Trenberth**, NCAR, Boulder, CO; and J. Fasullo and L. Smith
9:15 AM	J8.4	Toward an improved understanding of the global fresh water budget PDF **Peter H. Hildebrand**, NASA/GSFC, Greenbelt, MD
9:30 AM	J8.5	Representing the Mesoscale Organization of Convection in Prediction Models **Mitchell W. Moncrieff**, NCAR, Boulder, CO; and C. Liu

11:00 AM-12:00 PM, Thursday
Joint Session 9 Understanding and predicting the water cycle across scale part II (Joint between the Limited Water Supply Symposium the 16th Conference on Planned and Inadvertent Weather Modification)

Chairperson: Enrique R. Vivoni, New Mexico Institute of Mining and Technology, Socorro, NM

11:00 AM	J9.1	The role of fine-scale landscape and soil-moisture variability in convection initiation PDF **Fei Chen**, NCAR, Boulder, CO; and S. B. Trier and K. W. Manning
11:15 AM	J9.2	The representation of hydrological processes across spatial scales using the NASA-GSFC Land Information System (LIS) **Matthew Garcia**, UMBC/GEST and NASA/GSFC Hydrological Sciences Branch, Greenbelt, MD; and C. D. Peters-Lidard
11:30 AM	J9.3	Establishing the global fresh water sensor web PDF **Peter H Hildebrand**, NASA, Greenbelt, MD

11:45 AM J9.4 An End-to-End Hydrometeorological Forecasting System
John N. McHenry, Baron Advanced Meteorological Systems, Raleigh, NC; and G. S. Wilson, K. P. Georgakakos, C. D. Peters-Lidard, and M. Matreata

12:00 PM-3:45 PM, Thursday
Exhibits Open

1:30 PM-4:00 PM, Thursday
Joint Session 10 Understanding and predicting the water cycle across scales part III (Joint between the Limited Water Supply Symposium and the 16th Conference on Planned and Inadvertent Weather Modification)

Chairperson: Fei Chen, NCAR, Boulder, CO

1:30 PM J10.1 The Time-Integrated Random Access NEXRAD Database (TIRAND): description and opportunity
John N. McHenry, Baron Advanced Meteorological Systems, Raleigh, NC; and W. T. Smith

1:45 PM J10.2 Role of TRMM daily rain forcing of the Indian Ocean onto simulated intraseasonal-to-interannual climate changes in the tropics.
C. Perigaud, California Institute of Technology/JPL, Pasadena, CA

2:00 PM J10.3 Precipitation development in convective clouds over the eastern Arabian Penisula
Daniel Breed, NCAR, Boulder, CO; and T. Jensen, R. Bruintjes, S. Piketh, A. Al Mangoosh, and A. Al Mandoos

2:15 PM J10.4 Observed declines in mountain snowpack and changes in snow seasons
Philip W. Mote, University of Washington, Seattle, WA; and A. F. Hamlet, D. Lettenmaier, and M. P. Clark

2:30 PM J10.5 Intercomparison among TRMM, GPCP1DD and Radar-AMeDAS
Kenji Kamiguchi, MRI, Tsukuba, Ibaraki, Japan; and A. Kitoh and M. Hosaka

2:45 PM J10.6 How snowmelt onset varies with elevation
Jessica D. Lundquist, SIO/Univ. of California and USGS, La Jolla, CA

3:00 PM Coffee Break

3:30 PM J10.7 Discovery of Annual and Seasonal Precipitation Micro-Climates within South Louisiana: Impacts for Coastal Management
Suzanne Van Cooten, NDBC, Stennis Space Center, MS; and D. E. Barbe

3:45 PM J10.8 Detection and attribution of 20th Century hydrologic variations and change over western North America
Shaleen Jain, NOAA-CIRES Climate Diagnostics Center, Boulder, CO; and M. Hoerling

6:00 PM, Thursday
Ed Lorenz Symposium Banquet

Browse the complete program of The 85th AMS Annual Meeting

ARTIFICIAL ATMOSPHERIC IONIZATION: A Potential Window for Weather Modification

Phillip Kauffman and **Arquimedes Ruiz-Columbié**

Ionogenics
8 Coachmen Lane
Belford, MA 01730

Active Influence & Scientific Mngt
8696 Hanger Rd.
San Angelo, TX 76904

Abstract:

Galactic cosmic rays have been positively correlated to the Earth's low cloud cover. It is now evident that cosmic ray ionization is linked to lowering nucleation barriers and promoting early charged particle growth into the Aitken range. There is a substantially high probability that some of the charged particles grow to the 100 nm range and beyond to become CCN. There is also evidence that electrically charged aerosol are more efficiently scavenged by cloud droplets, some of which evaporate producing evaporation aerosol, which are very effective ice formation nuclei.

The assumption is made that artificially generated, corona effect ionization should act in much the same way as cosmic ray ionization, with some differences that might make unipolar corona effect ionization a more powerful catalyzer of cloud microphysical processes and, consequently, climate. There is much further work required to understand the cause and effect relationship between artificial ionization and weather, including electrical, chemical and physical measurements at the nanoparticle level and beyond, as well as mathematical modeling to describe the observed, measured or hypothesized atmospheric phenomena at different levels of artificial ionization, and, hopefully equal levels of cosmic ray ionization.

Introduction: Cosmic Rays and Cloud Processes

In 1997 Svensmark and Friis-Christensen reported a correlation between cosmic rays and cloud cover (1). They found that the observed variation of 3 – 4% of the global cloud cover during the recent solar cycle is strongly correlated with cosmic ray flux. This was hailed by some as the key to the mystery of how the sun affected climate and produced climactic changes. It was also a confirmation of the long standing suspicion that cosmic rays were linked to global cloudiness.

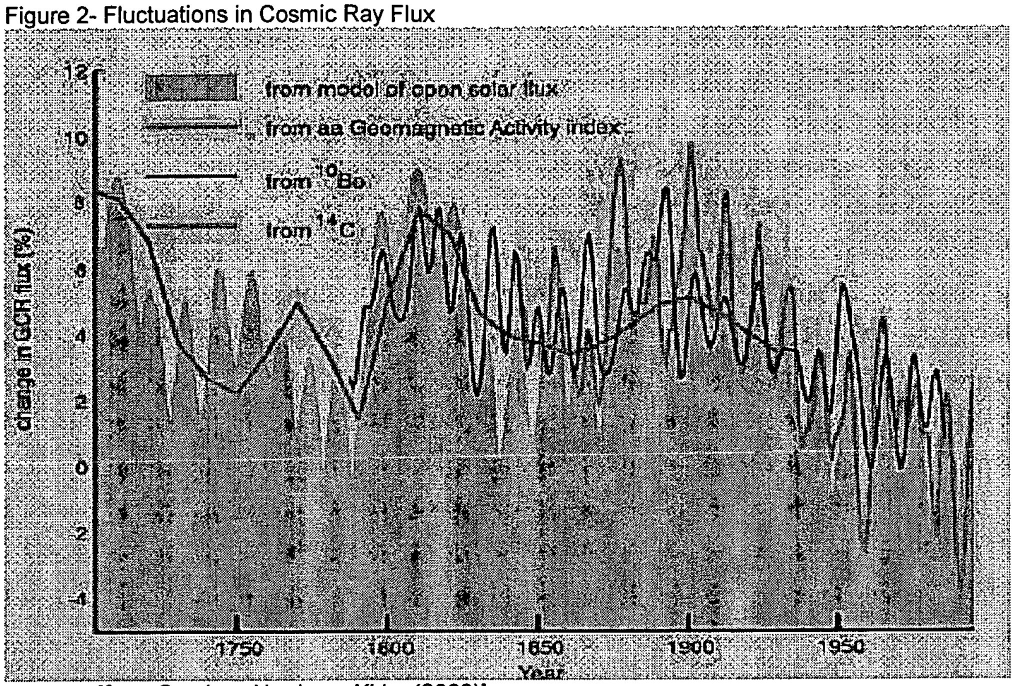
Numerous articles followed studying the catalytic effects of ions from cosmic rays on micro-physical cloud processes and cloud cover. Of particular interest is the observation from recent satellite data, that cosmic ray-cloud correlation is much more intense in low level clouds than in high level ones. More cosmic rays correlate to more low level clouds (altitudes of less than 3 km) and lower temperatures (1). Low clouds exert a large net cooling effect on the climate. Therefore, greater cosmic ray intensity translates to more cloud cover and cooler temperatures.

The link between global low cloud amounts and cosmic ray intensity has been published in the U.S. by Marsden and Lingenfelter who say: "The observed correlation between global low cloud amount and the flux of high energy cosmic rays supports the idea that ionization plays a crucial role in tropospheric cloud formation". (3)

Cosmic ray flux variability is not limited to a solar cycle. Although the energy input from cosmic rays is tiny, as the dominant source of ionizing particle radiation, they have a profound effect on many atmospheric processes. Through interaction with air nuclei they generate isotopes such as ^{10}Be and ^{14}C, which is the basis for Carbon dating and reconstructing past changes of cosmic ray activity. The model of open solar flux has been analyzed, together with data from archives recording ^{10}Be concentration in ice cores and ^{14}C rings on trees and a strong correlation has been observed (2).

From those observations, it has been established that cosmic ray intensity declined about 15% during the 20th century, roughly about the same variation as the last solar cycle, as can be seen in figure 2.

Figure 2- Fluctuations in Cosmic Ray Flux



[from Carslaw, Harrison, Kirby (2002)]

As can be observed, in the above graph, decadal, centennial and perhaps even millennial changes in GCR flux translates into long term weather changes. The correlation is not well established here and is, clearly, an open issue that warrants further modeling.

Ions produced by galactic cosmic rays are lost by one of three processes (4):

1. Ions are quickly lost due to a mechanism called ion-ion recombination.

2. Many of the remaining ions after ion-ion recombination will attach to aerosol, charging the aerosol.

3. When ion attachment occurs in a cloud, ions attach directly to water droplets, charging the droplet.

Ice Nucleation

Charged aerosol are attached easily to cloud droplets (scavenging). The resulting charged droplet, when at the cloud – clear air boundary, will often evaporate. When it does, all its charge and traces of the organic and inorganic aerosol it attached in the past remain with the evaporation nucleus.

This nucleus is now an effective ice formation nucleus. A supercooled droplet scavenges this evaporation nucleus and freezing can occur as a consequence of contact ice nucleation. This process is called electroscavenging (6).

Charged Versus Uncharged Clusters

Recent modeling work suggests that a charged atmosphere will have a lower nucleation barrier and will also help stabilize embryonic particles. This allows nucleation to occur at lower vapor concentrations. Other work by Yu and Turco [2000] demonstrates that charged molecular clusters, condensing around natural air ions can grow significantly faster than corresponding neutral clusters, and can preferentially achieve stable, observable sizes" (7)

The models also indicate that the nucleation rate of fresh aerosol particles in clean regions is limited by the ion production rate from cosmic rays (2).

Stable charged molecular clusters resulting from water vapor condensation and coagulation growth can survive long after nucleation. "Simulations reveal that a 25% increase in ionizing rate leads to a 7-9% increase in concentrations of 3 and 10 nm particles 8 hours after nucleation." (6)

Nucleation

Aerosol particles of terrestrial origin are formed by three major mechanisms:

(1) gas-to-particle conversion (GPC),

(2) drop-to-particle conversion (DPC), and

(3) bulk-to-particle conversion (BPC).

The first one precisely promotes the formation of new aerosol particles from nanoparticles and gives an important role to the present ions.

In the atmosphere where normal supersaturations do not exceed 2%, GPC without a pre-existing aerosol particle has, essentially, four nucleation sub-mechanisms:

Binary Nucleation:
($H_2SO_4 - H_2O$)

Ternary Nucleation:
($H_2SO_4 - H_2O - NH_3$)

Ion Induced Nucleation:
($H_2SO_4 - H_2O$ – Ion)

Ion Mediated Nucleation:
($(H_2SO_4)_n - (H_2O)_m$ – Ion)

The difference between IIN and IMN is that in IIN the ion is the one attaching to new molecules and in IMN it is the molecules within the cluster that are attaching to new molecules.

It has been observed that when the concentration of H_2SO_4 (or nitric acid) vapor is low, the observed nucleation rate is less than the predicted rate for binary nucleation. If there is a third species (such as, for example, ammonium or even an organic species) the observed ternary nucleation rate is much closer to the predicted rate.

The two proposed nucleation mechanisms that have been used to explain the observed nucleation events occurring in Earth's atmosphere are ternary nucleation and, preferentially, ion mediated nucleation (8)

Ionization and Cloud Properties

Recent observations, simulations, models and research establish a relationship between cosmic ray ionization and cloud microphysics "... A mechanism linking cosmic ray ionization and cloud properties cannot be excluded and there are established electrical effects on aerosol and cloud microphysics." (6).

Building on the relationship between low cloud cover and cosmic ray ionization the observations are extended to the realm of cloud microphysics by exploring this idea quantitatively with a simple model linking the concentration of cloud condensation nuclei to the varying ionization rates due to cosmic rays.

Cosmic rays produce positive ions and free electrons. Many of these ions will be quickly lost to ion-ion recombination. Some of the ions escape recombination because the ionization produced by cosmic rays often is skewed because the positive and negative ions that are generated are not exactly equal in number. Some of the ions escape recombination because their opposite charge would be combining ion attached to an aerosol instead. The surviving ions will either attach themselves to an aerosol, thus charging the aerosol, or else grow by condensation and coagulation into charged particles called ion clusters.

So far, we have ions that have attached to aerosol, ions that have grown to ion clusters and ions that have been lost by recombination to form neutral particles. Some of the ion clusters (subcritical embryos < 3nm) will quickly attach to aerosol, thus charging the aerosol, or else continue to grow through condensation and coagulation to become critical embryos, then through the Aitken particle size range of 3 to 80 nm and from there, some will become cloud condensation nuclei (CCN >100 nm). (2)

Aerosol particles of all sizes are capable of becoming condensation nuclei, provided the supersaturation is great enough. Direct condensation by water vapor onto ions cannot occur in the open atmosphere because the level of supersaturation (S) is far too high to occur in the atmosphere, it must be achieved in a laboratory, in a Wilson cloud chamber, for example (the level is approximately 400%; S=4).

If the condensation nucleus is large enough to cause condensation at atmospheric levels of supersaturation, usually no more than a percent or two and typically around 0.06% then the condensation nucleus is considered to be a Cloud Condensation Nucleus and is of primary interest in atmospheric physics.

Particle Growth Processes

Once ions have attached to aerosol, recombined with another ion or grown into aerosol, there are several aerosol particle processes that regulate

the concentration (number of particles cm^{-1}) of particles as well as the growth of these particles in the troposphere.

a. **Condensation**: This is a process where water molecules condense on an aerosol, changing phase from gaseous to liquid and releasing latent heat. The aerosol grows as it acquires water molecules, adding to its diameter and mass. Charged aerosol are more effective in inducing condensation than uncharged ones because polar molecules have an enhanced condensation rate. Calculations show that this growth rate is greater by a factor of at least 2, and, since a 5 nm particle's coagulation loss rate is $1/20^{th}$ that of a 1 nm particle, it is an important factor in determining the early survival rate of aerosol (2).
b. **Coagulation**: This is a process where molecules (ligands) attach themselves onto aerosol through agglomeration
c. **Scavenging**: The process whereby a cloud droplet collects an aerosol. If the aerosol is charged, the charge transfers to the droplet. The charged droplet will be further attracted to charged aerosol
d. **Electroscavenging**: When a cloud droplet reaches the clear air – cloud boundary it often evaporates, leaving behind all its charge to the nucleus as well as coatings of sulfate and organic compounds that the droplet absorbed while in the cloud. Charged evaporation nuclei enhance collection by droplets because of their coatings and because they create an image charge on the droplet. Even if the droplet is charged with the same polarity as the nucleus, the image charge will greatly enhance the possibility of attachment. In supercooled clouds, droplet freezing can create contact ice nucleation (5).
e. **Collision – Coalescence**: It is widely accepted that growth of droplets to raindrops by condensation of water vapor takes several hours (7). This means that the only probable mechanism for droplets to grow into raindrops is by collision. Larger drops fall faster than smaller drops, so they sometimes collide. However, the air pressure of the larger, faster falling drop will, even if it is in a collision course with a smaller drop, may make the smaller drop go around the larger one and prevent collision. This is the same aerodynamic principle that causes most insects to avoid collision with an oncoming car, because the elevated air pressure surrounding the car will propel the insect away from the car. The collision efficiency of charged aerosol-droplet is increased by thirty-fold for aerosol carrying large (>50) elementary charges (9). It is possible that charged droplets collide with larger falling droplets by inducing the same type of image charge over and over again until a raindrop is formed, given a sufficiently large elementary charge. The following diagram shows how neutral aerosol escape collision because of streamline pressures, whereas charged aerosol cross streamlines, resulting in collision (9).

Partial Summary

Most ions generated by galactic cosmic rays will be lost because of ion-ion recombination. The remaining ions will catalyze the nucleation of ultrafine, stable particles (<1-2 nm) by condensation. Once this happens:

- Most of them will feed larger existing particles (aerosol) thus increasing particle size and catalyzing the process of CCN formation,
- Some will be scavenged by cloud droplets, contributing to the cleansing effect of depositing small particles (pollutants) on the ground, and,
- A fraction of the ultrafine condensation nuclei will again condense and coagulate to form critical embryos (2-5 nm) and a fraction of the former will again coagulate and condense to form cloud condensation nuclei (~100nm).
- Some CCN will grow through condensation and coagulation to form cloud droplets (activation).
- Charged aerosol can grow to become ice formation nuclei through electroscavenging.

Hypothesis: General Statement and Conceptual Model

Ions produced by direct current generators by corona effect will add to and enhance the catalyzing effects that cosmic ray ions are now known to produce in, among other things, lowering nucleation barriers, stimulating charged particle growth and stability and increasing the scavenging rate in clouds.

The injection of a large number of DC corona effect ions will induce changes in cloud microphysics and cloud cover and, consequently modifications in weather conditions. For reasons explained below, it is expected that DC generated ions are going to be a more aggressive catalyzer than cosmic rays.

Hygroscopicity

It is clear that corona generated particles are hygroscopic and grow rapidly with increased humidity, while laser created particles are only weakly influenced by humidity (10) thus reinforcing the possibility that corona effect ionization will complement or even potentiate cosmic ray ionization's effect on cloud physics.

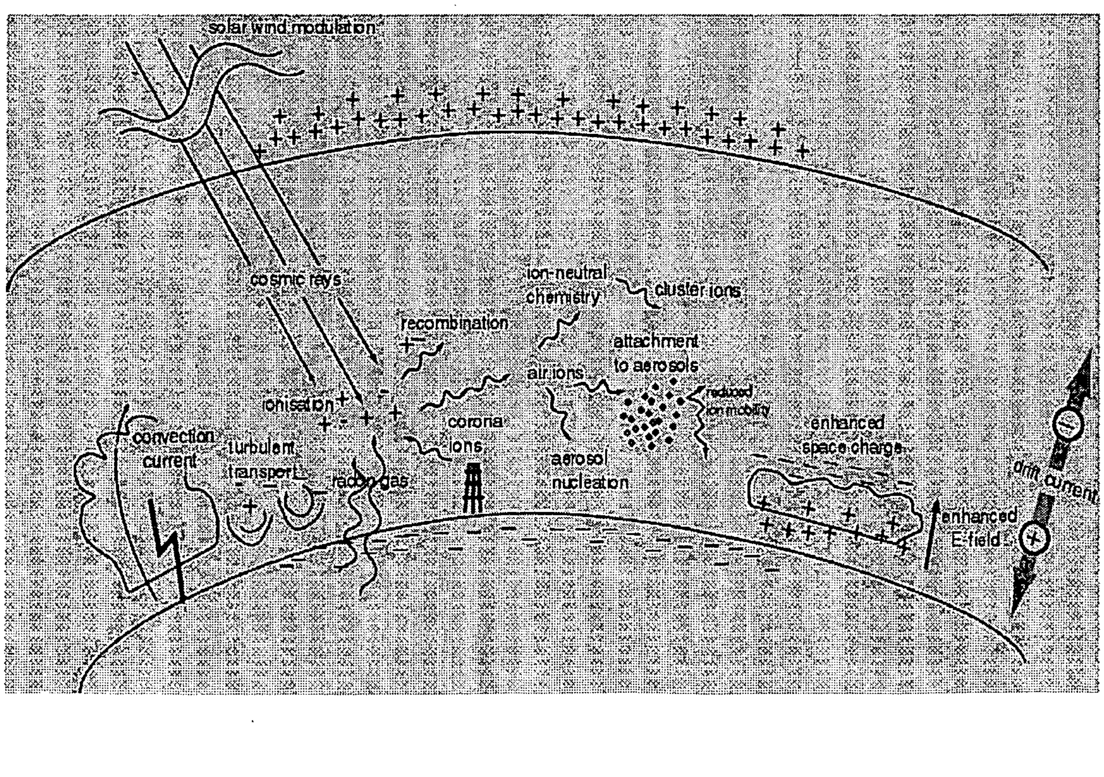
Ion Losses

Since all DC generated ions will have the same polarity, very few ions will be lost due to ion-ion recombination. That means that almost all these small ions are lost only by ion-aerosol and ion-droplet attachment in clouds. What this means is that almost all the ions produced by direct current sources are available to feed aerosol or droplets.

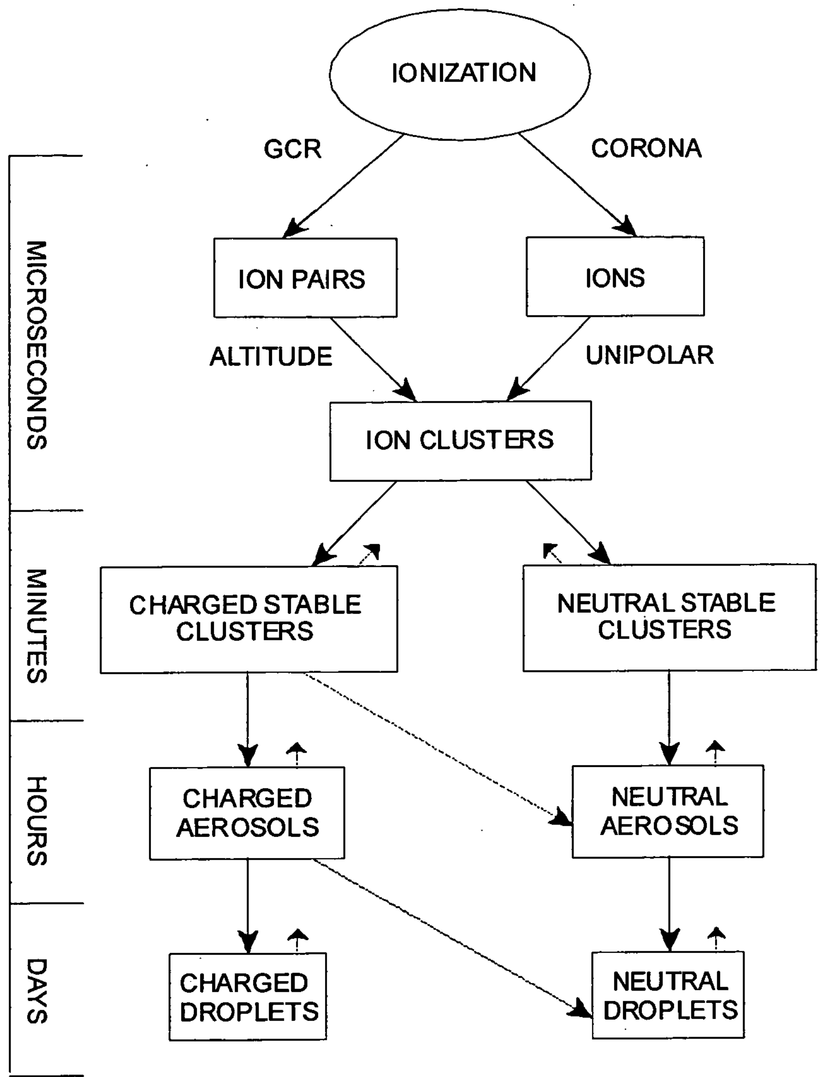
Other Considerations

1. Particle growth processes will essentially be the same as for particles ionized by cosmic rays.
2. Just like particles ionized by cosmic rays, particles ionized by corona effect ions will quickly stabilize and grow to the critical embryo (1-2 nm) and beyond, to the Aitken particle phase.
3. Certainly Aitken particles and perhaps some growing critical embryo particles have the stability that is required to survive long enough to reach and surpass the PBL through convection, turbulence and thermals.
4. Ionization may improve conductivity in the lower atmosphere by cleaning pollutants which are barriers to the Earth's natural current flow. If the atmosphere is cleansed of pollutants, increased precipitation will be achieved.

Corona effect ions may have a role in catalyzing atmospheric phenomena as suggested by R.G. Harrison and K.S. Carslaw in 2003



Conceptual Model



The conceptual model diagrams the operation of natural (galactic cosmic ray produced) and anthropogenic direct current corona effect ionization operating in parallel. Galactic cosmic ray ionization is greater in the upper levels of the atmosphere and only a small fraction of ions reach the lower levels of the troposphere. Cosmic ray ionization has the advantage that it occurs at the tropospheric level that is of interest (0.5 – 3 km), whereas corona effect ionization occurs at ground level and so it can only reach the altitude required by creating stable particles that gain altitude by the atmosphere's convective current, turbulence or thermals.

In both cases, cosmic ray or corona ions, will quickly (< s) form ion clusters that have the stability and lifetime to allow them to either attach or grow by condensation and coagulation into stable charged clusters. This will happen in a time-span of a few minutes. In either case the net effect of ionization will be to charge pre-existing aerosol or form new charged aerosol. Aerosol have lifetimes measured in hours and sometimes days, depending on a wide array of variables.

Aerosol may grow to become CCN and, CCN, in turn, may activate to become water droplets.

Water droplets may collide and coalesce to become raindrops.

At any stage of evolution, particles may lose their charge and become neutral. When this happens, the particle loses its preferential growth capabilities, thus decreasing its probability of becoming a CCN. Also, at any point in the process, the reverse path may apply. Thus charged aerosol may grow by condensation and coagulation into CCN, but a portion of the CCN might also lose their CCN size by evaporation and become, once again, charged aerosol (or even uncharged aerosol if they lose their charge as well). In general, however, the model proceeds according to the above diagram.

Epilogue: a Brief Philosophical Consideration

Cloud seeding has been the predominant tool used during the short history of the **Advertent Weather Modification discipline**. It pretends to induce instability in cloud processes by using chemical agents. Experimental and operational works have suggested that glaciogenic seeding might produce increases in snow and rain of about 10 % over an area, whereas hygroscopic seeding is still under scrutiny. However these increases do not seem to be enough to solve the increasing demands of water in many regions on Earth and the discipline of Weather Modification urges to broaden its horizon. On the other hand, **Inadvertent Weather Modification** has pointed out that the anthropogenic byproducts can produce irreversible alterations in local weather. In particular, gas-to-particle conversion appears to be the mechanism through which great non-intentional alterations might be acting on specific local and regional areas. The hypothesis here presented suggests that atmospheric ionization might be used intentionally to improve degraded weather.

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WEATHER MODIFICATION ADVISORY COMMITTEE

August 12, 2004 – 10:30 a.m.
E.O. Thompson Building – 7th Floor Public Meeting Room - Austin, Texas

Summary of Minutes

Acting Presiding Officer, Bruce Rigler called the meeting of the Weather Modification Advisory Committee to order at 10:32 a.m., Thursday August 12, 2004. Committee members present were Acting Presiding Officer, Bruce Rigler; Dr. Richard Orville; and Everett Deschner. A quorum was present. Committee member Everett Deschner left the meeting at approximately 11:30.

Acting Presiding Officer, Bruce Rigler moved to agenda item C., Approval of minutes – Meeting of April 22, 2004. Committee member Everett Deschner made a motion to approve the minutes as presented. Committee member Dr. Richard Orville seconded the motion. The motion passed by unanimous vote.

Acting Presiding Officer, Bruce Rigler moved to agenda item D., Public Comment. There was no public comment at this time.

Acting Presiding Officer, Bruce Rigler moved to agenda item F., Discussion and Recommendation on Applications for Renewals of Texas Weather Modification Licenses for Fiscal Year 2005. George Bomar, Program Specialist, provided an overview of all requested license renewals.

At approximately 10:40 a.m., Committee member Frank Reilly joined the meeting.

Committee member, Everett Deschner made a motion to approve all applications, excluding the Southwest Texas Rain Enhancement application. Committee member, Dr. Richard Orville seconded the motion. The motion passed with a unanimous vote.

Committee member, Dr. Richard Orville made a motion to renew the application for Southwest Texas Rain Enhancement but add Stephanie Beall at a later date. Committee member Frank Reilly seconded the motion. The motion passed with a unanimous vote.

George Bomar provided an overview of the application from Belding Farms. Committee member Everett Deschner made a motion to approve the application. Committee member Dr. Richard Orville seconded the motion. The motion passed with a unanimous vote.

Acting Presiding Officer, Bruce Rigler moved to agenda item G., Discussion and Recommendation on Applications for Texas Weather Modification License: Ionogenics, Inc. George Bomar provided an overview of the application. Phillip Kauffman showed a Power Point slide to the Committee and provided the Committee with additional information regarding Gianfranco Bisiacchi's qualifications. Committee member Everett Deschner stated that would approve the application for licnese without the name of Dr. Bisiacchi because he felt that Dr. Bisiacchi did not satisfy the requirements. Mr. Deschner also stated that he did not think Ionogenics had yet given a credible hypothesis to show why the system should work. Mr. Deschner requested calculations on the amount of electrical flux to be generated or something of that nature, which he felt was necessary before considering the application. Committee member Dr. Richard Orville stated that he felt Dr. Bisiacchi should provide evidence of interaction with the professional community which he felt was very necessary in the process of weather modification. After further discussion, Committee member Frank Reilly made a motion to recommend approval of the application with James Selasky as the meteorologist of record and no recommendation on whether Dr. Bisiacchi should be on the license as well. Committee member Dr. Richard Orville seconded the motion. The motion passed with a unanimous vote.

Acting Presiding Officer, Bruce Rigler moved to agenda item H., Discussion and Recommendation on Application for Texas Weather Modification (Rain Enhancement) Permit: Ionogenics, Inc. Committee member Dr. Richard Orville made a motion to table the application. Committee member Dr. Richard Orville withdrew his motion. Committee member Frank Reilly made a motion to forward the application to the Department Executive Director with no recommendation. Committee member Dr. Richard Orville seconded the motion. The motion passed with a unanimous vote.

Acting Presiding Officer, Bruce Rigler moved to agenda item E.1., Staff Reports, Status of Rain-Enhancement Projects in Texas. George Bomar provided a status of rain-enhancement operations. Project representatives provided comments to the Committee.

Mr. Bomar continued to agenda item E.2., Staff Reports, Status of State Grant Program for Rain Enhancement Operations. George Bomar reported on the status of projects using state grant money and the remaining funds. Mr. Bomar informed the Committee that the Texas Weather Modification Association had recently met. Tommy Shearer provided a brief update of the meeting.

Mr. Bomar continued to agenda item E.3., Staff Reports, Status of Weather Modification Research and Assessment Activities. George Bomar provided an overview of planned research in the Texas-Oklahoma area. Mr. Bomar also reported on the status of Federal appropriations legislation.

Mr. Bomar continued to agenda item E.4., Staff Reports, Update on adoption of Revised Weather Modification Rules. Chris Kadas, General Counsel, reported that the Texas Commission of Licensing and Regulation adopted the rules recommended by the Committee.

Mr. Bomar continued to agenda item E.5., Staff Reports, Status of amendments to Texas Weather Modification Permits. George Bomar informed the Committee that all operation plans, excluding the Colorado River Municipal Water District, had been amended to reflect that the primary radar system now being used for diagnostic purposes is the Doppler data feed purchased from Weather Decision Technologies, Inc.

Acting Presiding Officer Bruce Rigler moved to agenda item I., Recommendations for agenda items for next meeting. George Bomar stated that all license renewals would be done before September 1, 2004. Mr. Bomar indicated that he did not see any prospects of any new permit applications. Mr. Bomar stated that the Department may have information to provide from a public meeting pertaining to Ionogenics' permit application. Mr. Bomar also stated that Powell Plant Farms' license would be expiring at the end of August, but an application had not yet been received.

Acting Presiding Officer Bruce Rigler moved to agenda item J., Discussion of date, time, and location of next Committee meeting. The Committee decided to possibly meet on November 18, 2004.

Acting Presiding Officer Bruce Rigler moved to agenda item K., Adjournment. Committee member Frank Reilly made a motion to adjourn the meeting. Committee member Dr. Richard Orville seconded the motion. The motion passed with a unanimous vote. The meeting adjourned at 12:26 p.m.

Bruce Rigler, Acting Presiding Officer
Weather Modification Advisory Committee